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Defining the learning curve for video-assisted thyroidectomy

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ABSTRACT

Background and aim: Several studies have demonstrated that endoscopic thyroidectomy is a safe technique. Aim of the study is to evaluate the feasibility of video-assisted thyroidectomy (VAT) performed by a junior surgeon.

Materials and methods: We consider 67 consecutive standard VAT gasless approaches. VAT was performed by an under 35-years-old surgeon trained in basic laparoscopy tutored by an experienced surgeon. Outcome measures were operative and hospitalization times, incision length, and complications. Conversion to open surgery was defined as the need to perform a longer incision. To establish the number of procedures required before achieving a safe VAT technique, procedures were divided into three chronological groups of about 30 lobectomies (Groups 1, 2, and 3).

Results: Success rates of VAT were 90% in group 1, 97% group 2, 100% group 3 respectively ($P < 0.05$). Most conversions were due to bleeding. In group 1, the overall mean operative time was 111 min, group 2, 93 min, group 3, 86 min ($P < 0.03$). Mean length of incision significantly increased from the initial incision: group 1, +1.3 cm, group 2, +0.9, group 3, +0.5 cm ($P > 0.05$). Group 3 had a faster recovery after surgery. The incidences of temporary hypoparathyroidism were 8.9%. The incidences of temporary RLN injury were 2.9%.

Conclusions: To date there are no recommendations regarding the amount of endoscopic training required to safely perform VAT, but our experience demonstrated that surgeon's age cannot be considered having a negative effects on results. Success of VAT technique was considerably associated with experience: improved operative variables and safe technique were seen after 30 lobectomies.

1. Introduction

Although evidence-based data reporting short- and long-term outcomes data after endoscopic resections for different thyroid diseases showed clear advantages in comparison with traditional procedures, mini-invasive thyroid surgery has not been already accepted.[1–8] One of the reasons for this initial refusal is partly due to technical difficulty of endoscopic resection requiring adequate training both in open and endoscopic procedures before safely perform gland resection.[8]

The number of cases required to overcome the so-called "learning curve" for video-assisted thyroidectomy (VAT) has not been set yet. Furthermore, it seems that VAT is usually performed by surgeons with a wide experience on open surgery as well as a fairly good training in endoscopy.[1–7]

The aim of this study is to demonstrate feasibility and safety of VAT performed by an under 35 years surgeon fully trained in minimally invasive procedures tutored by older colleague experienced in open procedures.

2. Methods

VAT has been practiced in our Center since 2004. From June 2004 to May 2008 we analyze prospectively short- and long-term results of VAT procedures for the treatment of malignant and benign thyroid diseases. VAT has been carried out by an under 35-years-old single surgeon (GD), performing more than 150 open procedures per year in an academic setting along with resident trainees or medical students, fully trained in several basic endoscopic procedures tutored by an experienced surgeon (RD). Selection and exclusion criteria for patients were: thyroid nodules less than 30 mm on their largest diameter, thyroid gland volume less than 20 ml, as estimated by high-resolution Doppler ultrasound (US) with both 7.5- and 12-MHz linear array transducers (MyLab™70 XVG, Esaote, Genova, Italy) (nodule and gland volume were estimated by sonographic

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measurement assuming spheroid size = [height × width × depth] × [PI]/6 or, approximately, [height × width × depth] × [PI]/2), no history of thyroiditis or previous neck surgery or irradiation, presence of a benign nodule or of a "low risk" papillary carcinoma and absence of enlarged lymph nodes suspicious for metastasis.[9,10] To gain experience in this field, scientific background of the first author included a University internship and training at the University of Pisa, Italy, Department of General Surgery (Dr. P. Miccoli) for four months. Moreover, one resident spent one week to acquire tips to handle endoscopic camera. A standard VAT gasless approach to the thyroid gland is performed.[9,10] All VATs were performed in general anesthesia. Option for controlling hemostasis during VAT included the vessel sealing system (VSS) (LS1520-LigaSure™, Valley Lab). The Nerve Integrity Monitor (NIM-Response 2.0 System, Medtronic Xomed, Jacksonville, Florida) was used for laryngeal nerves monitoring. Our standard technique is to stimulate both the vagus nerve and the RLN before and after thyroid resection.[11–13] Personal gain of experience was defined by the preceding number of thyroid operations. All operations were indexed consecutively with a running number. Conversion to open surgery was defined as the need to perform a cervical incision longer than 3 cm.[14] Main surgical outcome measures were patient demographics, weight of the thyroid gland, type of operation performed (total thyroidectomy vs. lobectomy), mean operative (skin incision to skin closure) and hospitalization times, intraoperative exposition of RLN and parathyroid glands, blood loss (through dissection–suction spatula device and weighing the gauze before and after use) incision length, post-operative complications, analgesic requirements (intravenous AIV and oral AO) and follow-up. Length of incisions was measured after wound closure and recorded in the operative report. The following complications were analyzed: intra- and post-operative bleeding, seromas, wound infections, transient or definitive laryngeal nerve lesions, uni- or bi-lateral, permanent or transient hypocalcemia and parathyroid gland autotransplantation. Hypocalcemia was checked by preoperative and daily serum calcemia, starting from the first post-operative day and 7, 14 days, than 1, 3, 6 months after surgery. Intact parathyroid hormone (iPTH) levels were also determined post-operatively.[15] Significant hypocalcaemia was defined as experiencing signs or symptoms of hypocalcaemia and/or having a serum calcium level that was ≤7.5 mg/dL (low end of normal for assay used = 8.5 mg/dL). Patients with post-operative hypocalcemia were discharged on a therapeutic regimen of oral calcium and cholecalciferol, which was continued until normalization of the calcium level. Pre- and post-operative follow-up included for all patients direct laryngoscopy to check vocal cord mobility performed at 24–48 h before and within 2 weeks after the surgical procedure by an independent laryngologist. Any reduction in the movement of the cord was recorded as post-operative cord paralysis. For those patients with documented post-operative cord palsy, repeated examinations were performed periodically at 1, 2, 6, and 12 months after the operation until full recovery of vocal cord function had been confirmed usually after logopedy. Hypoparathyroidism and RLN palsy were defined as permanent when there was no evidence of recovery within 6 months of surgery. As surgical experience in endoscopic surgery is an important variable for incision length, the mini-incision was routinely measured at the end of the endoscopic procedure and compared with the initial standard approach (i.e. 1.5 cm). Hospital discharge was proposed at 24–48 h after the operation if no signs of complications were present. Time to return to normal activity was also analyzed (i.e. normal physical activity includes indoor and outdoor activities that can be scheduled into a regular routine). Patients were followed pre- and post-operatively in collaboration with the Division of Endocrinology of the University of Insubria, Varese, Italy. For cancer patients, after surgery, patients were submitted to thyroid remnant ablation by radioactive iodine (^{131}I) and placed under TSH-suppressive L-thyroxine therapy.[16] Preoperative diagnosis was based on ultrasound-guided fine needle aspiration cytology and serum calcitonin measurement.[16] If a parathyroid gland appeared to be damaged or hypovascularized, we reimplanted it in the sternocleidomastoid muscle. No thyroid bed drainage was necessary.[9,10] No patients received antibiotics prophylaxis.[17] All patients received the same post-operative protocol.

3. Statistical analysis

Statistical analysis of the results has been conducted with the software MedCalc for Windows, version 8.1.0.0 (MedCalc Software, Mariakerke, Belgium), using nonparametric tests. Descriptive data are reported as mean ± standard deviation, range and median or number of patients and percentage. The Mann–Whitney *U*-test was used to compare the ordinal independent variables and the chi-square test, or the Fischer's exact test when appropriate, to compare discrete variables. A *P*-value <0.05 has been considered statistically significant.

4. Results

Over period of 48 months, 718 patients underwent thyroid resection, of these 67 (9%) were VAT (43 women and 24 men, mean age 39.8, range 19–70 years). Complete follow-up was available for all patients. The overall mean thyroid volume estimated by preoperative US was 16 (range 11–25) ml. Mean size of dominant nodules was 2.1 cm (range 1.2–3.2 cm). The treated pathologies were mainly follicular tumor ($n = 35$, 52%), nodular goiter ($n = 23$, 34%), papillary carcinoma (6), Hurtle (3). There were no statistical differences in the study period for distribution of epidemiological characteristics, thyroid pathology, types of operations, the proportion of bi-lateral procedures and mean weight of the gland. There were 55% total thyroidectomies ($n = 37$) and 45% hemithyroidectomy ($n = 30$), thus providing 104 lobectomies to analyze. To establish the number of procedures required before achieving an effective and safe VAT technique, all of these procedures were divided into three chronological groups of about 30 lobectomies (Groups 1, 2, and 3). There were no statistical differences between the three groups for distribution of epidemiological characteristics, thyroid pathology, mean weight of the thyroid and proportion of right/left thyroid lobe procedure (data not shown).

There were 3 conversions to open surgery in group 1, 1 case in group 2, and 0 in group 3. Thus, the success rates of VAT were 90% (27/30) in group 1, 97% (29/30) group 2, 100% (30/30) group 3 respectively ($P < 0.05$). Conversions to open procedure were due to inadequate surgical exposure for intraoperative bleeding (1 case), 1 because of inability to identify left RLN, 1 case for invasive cancer and 1 due to adhesions (previously undiagnosed thyroiditis).

There were no statistically significant differences between the groups in terms of intraoperative bleeding.

In group 1, the overall mean operative time was 111.0 (78–139) min, while operative time in group 2 was 93 (66–134) min, group 3 was 86 (59–101) min ($P < 0.03$). At the end of VAT procedure, the mean incision length was 21 ± 6 mm. The final mean length of wound incision significantly increased from the initial incision (i.e. 1.5 cm) in particular in the first group of procedures: group 1, +13 mm; group 2, +9 mm and group 3, 5 mm ($P > 0.05$).

There were no statistically significant differences between the groups in terms of AIV and AO narcotic used.

In group 1, 46% (14/30) experienced an overnight hospital stay (<24 h), 66% (20/30) group 2, 80% (24/30) group 3 respectively ($P < 0.05$). Return to normal activity occurred after 9 ± 7.6 days in the first group, after 7.1 ± 4.2 and 5 ± 3.5 days in the second and

third group ($P < 0.05$). Thus, patients of group 3 had a faster recovery after surgery.

No mortality was observed. Overall morbidity was as high as 13.4% (9/67) and in most cases included transient complications. No patient required reoperation. One patient in the study group experienced a wound seroma (group 2). We document a 5.9% (4 patients) incidence of skin injury from thermal damage from electrosurgery or from the endoscope: 2 cases in group 1, 2 in group 2 and no cases in group 3. No bi-lateral vocal cord paresis or paralysis occurred. There were no cases of permanent hypocalcaemia or RLN paralysis. The incidences of temporary hypoparathyroidism were 8.9% (6/67). One patient was readmitted with a diagnosis of symptomatic hypocalcemia 3 days after discharge.

The rate of intraoperative identification of at least 2 parathyroid glands per lobe during VAT was: 51/60 (85%) group 1, 56/60 (93%) group 2, 57/60 (95%) group 3 ($P < 0.05$).

The RLN was identified in 103/104 cases (99%): the inability to identify one left RLN leads to conversions to open procedure (group 1). The incidences of temporary RLN injury were 2.9% (2 patients). Because of insufficient numbers of morbidities (RLN injury and temporary hypoparathyroidism) a statistically significant result was not achieved comparing different study groups.

5. Discussion

Attracted by the undisputed advantage of the other laparoscopic and thoracoscopic procedures, endoscopic thyroid surgery has quickly gained popularity.[18,19] Recent evidence base data have demonstrated that minimally invasive thyroid surgery, in selected patients, has clearly good results regarding safety, morbidity, patient cure rate and comfort, with few post-operative pain and excellent cosmetic results.[1–7]

Endoscopy in thyroid surgery is appealing. However, the adoption of this technique is hampered by the steep learning curve and the fear of exposing patients to excessive prolongation of operative time and morbidity. To date there are no proper recommendations regarding the amount of general and minimally invasive training required to safely perform VAT, but our experience demonstrated that surgeon's age it cannot be considered having a negative effects on results. Our study demonstrates that results obtained by an under 35-year-old surgeon, trained in laparoscopic surgery can be at least as good as the ones obtained in open surgery. Our results are also comparable to larger single institution series.[9,10] One of the main factors influencing these results is the constant presence, during all procedures of a senior experience thyroid surgeon who was able to tutor during the different steps of the procedure.[20]

We assessed how many patients should be operated to overcome this learning curve. In this study, the success rates of VAT technique were considerably associated with experience. A clear turning point, with improved operative variables and safe technique, was seen after about 30 lobectomies. Patients were not exposed to excessive morbidity during this learning curve. Our data demonstrate the substantial feasibility of this procedure, as reflected by a low conversion rate to conventional surgery. Moreover, conversion rate significantly decreased after the first 30 procedures. Intraoperative identification of RLN and parathyroid glands improved with experience. The length of operation and wound incision decreased after the first 30 cases. Gradually, physical activity increased, with normal activity resuming in few days after surgery (group 3). In this study, most of unsuccessful VAT cases were due to an inadequate surgical exposure due to bleeding. Intraoperative bleeding during VAT is a cause for conversion to the open technique. Current and future trends in research in endoscopic surgery must focus on developing dedicated surgical instruments optimizing dissection and hemostasis control.

Conflict of interest
None declared.

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Ethical approval
The protocol and consent were approved by the local institutional review board and written informed consent was obtained from each patient in advance.

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